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SPECIES, PURE AND IMPURE[1]

THERE has come about in recent years a profound modification of our conception of a species in that the botanist, at any rate, is compelled to recognize the fact that Nature presents large numbers of successful kinds of plants that reproduce their types either wholly or in high percentages, but which clearly have germinal constitutions of a hybrid character. These forms may legitimately be described and classified as species and they are frequently virile lines of evolution making up groups of individuals that readily maintain themselves in suitable habitats. As assemblages of like individuals, hybrid as to their germ plasm, they present subjects of study that were not differentiated by the earlier naturalists from the populations of species as they viewed them.

The test of a species, in addition to the characters that distinguish it, has always been the evidence that it breeds true to its peculiarities or so nearly true that variations from the type may be passed over in the descriptive writings of the systematist as exceptions of little importance to the mind seeking for order and rebellious of mental disturbance in his efforts to express this order in accounts of faunas and floras over the earth. There are, then, chiefly as the result of genetical studies of the near present, two conceptions of species.

There is the *pure species* breeding true because its germ-plasm in the diploid condition carries two similar sets of factors, each set contributed by one of the parents and each set having the same genetic make up except for those factors responsible for sex and for sex-linked characters. The pure species was in the main the concept of Darwin and the older naturalists, and it was assumed to be representative of species. As viewed by the cytologist, confident that chromosomes carry

[1] Address of the president of the American Society of Naturalists, thirty-ninth annual meeting, Toronto, December 29, 1921.

the factors or genes responsible for inheritance, the pure species owes its characteristics to the fact that parents contribute chromosomes of identical factorial constitution and therefore give to the zygote pairs of homologous chromosomes with the exception that genes which differentiate sex can only be present in single sets. Expressed in the terminology of the geneticist the pure species is homozygous for all genes responsible for the species' characters other than those of sex, and for sex characters the germ-plasm is heterozygous in either the male or female individual at least where animal forms are under consideration. The problems of sex determination from the diploid sporophyte generations of plants are not yet fully solved. Aside from the possibilities of factorial mutations and of mutations due to irregularities of chromosome distribution a pure species must develop gametes identical for all genes other than those of sex, or linked with sex, because the homologous chromosomes during the reductions divisions separate from one another. Some authors would strictly limit the term species and accept that definition of Lotsy (1914), "A species is the total of all individuals of the same hereditary composition, forming but one kind of reproductive cell." I cannot agree with this opinion since the definition calls for what is almost an abstraction in higher animals and plants, the absolutely pure race.

In contrast to the pure species as defined above is the *impure species,* the germ-plasm of which in the diploid condition carries different sets of genes affecting characters other than those associated with sex. With respect to these genes the germ-plasm is heterozygous and through the reduction division there must take place a segregation of genes with the result that the impure species cannot produce a uniform set of gametes, that is, gametes identical in their germinal constitution. If the diploid germ-plasm is heterozygous for one pair of chromosomes other than the sex chromosomes there would be developed through the separation of the different chromosomes of such a pair two classes of gametes of each sex provided that reduction proceeds in a normal manner. If heterozygous for two pairs of chromosomes there would be developed under normal conditions of meiosis four classes of gametes of each sex, and the theoretical possibilities when larger numbers of heterozygous chromosome pairs are present may be calculated by the well known genetical formula (2^n) when n = the number of heterozygous chromosome pairs.

The impure species is therefore clearly hybrid in its genetical constitution but there is this peculiarity in its breeding behavior that it frequently shows little or no evidence of a segregation of contrasting genes. There is in such cases no obvious splitting off of classes through its progeny, but, on the contrary, the impure species breeds true or nearly true to its type. The true breeding of an impure species must be due to the fact that only favored types of gametes are able to produce in conjugation vigorous zygotes capable of successful development. Furthermore, such favored gametes must carry between them those genes which in combination will reproduce the impure heterozygous germinal constitution of the parent stock.

It is well understood from various plant material that the failure of a hybrid to produce a diverse progeny may be due to irregularities at a number of different points in the life history. The death, the sterility, or the failure of maturation of classes of gametes will eliminate the possibilities of development of whole groups of segregates. Even when viable classes of gametes are formed some may leave no progeny because in conjugation they fail to produce zygotes able to develop a succeeding generation. In plants the length of style, or the nature of its tissues, or of its stigma secretions may operate to check or to limit pollen tube growth or the speed of such growth for some classes of pollen grains and at this point in the life history prevent the functioning of pollen tubes carrying particular types of gametes. Pollen and ovule abortion in greater or less degrees is a very common phenomenon and is responsible at times for the elimination of entire classes of gametes. High degrees of seed sterility and the weak germination of seeds express the

failure of certain types of zygotes to develop a succeeding generation. Explanations for all of these conditions may be offered by postulating lethal factors, as suggested by the work on Drosophila, but it is well to understand for plants how various are the ways in which lethal factors may block the course of development and how numerous are the points at which they may operate.

The significance of the impure species and the importance of its place in certain natural groups is not yet appreciated. Curiously the plant most conspicuously brought to the front as one giving rise to new species by mutation has become one of the forms most thoroughly studied as an example of an impure species. I refer of course to the plant *Œnothera Lamarckiana.* Presented by De Vries as the best illustration of his view that pure species at times pass through periods when they actively produce by large saltations new species, the status of *Œnothera Lamarckiana* from the first became a subject for sceptical examination on the part of a body of naturalists who hesitated to accept De Vries' conclusions, and sought for other hypotheses to account for its remarkable behavior. Bateson was the first to suggest that the fifty per cent. or more of pollen sterility in *Lamarckiana* indicated a hybrid constitution. Jeffries pushed this argument with force through comparisons of pollen sterility in *Lamarckiana* with similar conditions in various known hybrids. Workers with Œnothera now generally recognize for most of their material the presence of very high degrees of sterility both gametic, as indicated by bad pollen and abortive ovules, and zygotic, as shown by large proportions of seeds incapable of germination. Renner has recently taken the subject of pollen analysis to a new level by showing that genetic classes of pollen may be distinguished in *Lamarckiana* and in some other œnotheras by differences in the form of the starch grains within the pollen cell and pollen tube. Cytological studies of Gates, Lutz, Stomps, Hance, van Overeem and others have shown that certain of the variants thrown by *Lamarckiana* differ from the parent type in having higher chromosome numbers due to non-disjunction. This non-disjunction seems correlated with a loose association of chromosomes in *Lamarckiana* and other œnotheras that favors irregularities of chromosome distribution at meiosis such as may be expected in hybrid material. Much breeding evidence, chiefly from the work of De Vries, has made it clear that *Lamarckiana* and other œnotheras develop two or more classes of fertile pollen grains which give in various crosses sets of hybrids in pairs, in threes and in fours, good evidence of hybrid behavior. I have shown that with care in the selection of parent stock it is an easy matter to synthesize a large-flowered vigorous hybrid with so many points of resemblance to *Lamarckiana* that it would be difficult to separate in descriptive botany the hybrid from the assemblage of biotypes that pass under the name *Lamarckiana* which, as Heribert-Nilsson has so well brought out, represents a collective species. Furthermore, this hybrid, an impure synthetic species, which I have called *neo-Lamarckiana,* has thrown in each of six generations from selfed seed similar sets of marked variants, and, as pollen parent in appropriate crosses, gives twin hybrids thus paralleling in essentials the characteristic performance of *Lamarckiana.* It is of interest that among the variants from *neo-Lamarckiana* there appear occasional triploid and quadriploid forms comparable to *semi-gigas* and *gigas.* There is no reason to expect that *neo-Lamarckiana* will ever be other than an impure species no matter how close may be the inbreeding and selection to type. It breeds true through only a small proportion of its progeny and we can see nothing that might change this habit so long as the line lives. Finally, against the assumption that *Œnothera Lamarckiana* is a pure species is the fact that the plant is unknown as a wild species and there is strong probability that it arose as a hybrid in England about the middle of the last century.

These are some of the reasons why geneticists rather generally have come to the conclusion that *Œnothera Lamarckiana* is representative of an impure species which reproduces its heterozygous constitution because the viable zygotes produced are for the most part only those resulting from the union of two

different types of gametes, which in combination reproduce the heterozygous *Lamarckiana* complex. Renner in 1914 presented this point of view, after studies on seed sterility in several species of Œnothera, and the conception of impure Œnothera species was rather fully discussed in my paper "The test of a pure species of Œnothera" published in 1915. Thus certain workers with Œnothera were fully aware of the possible significance of gametic and zygotic mortality in relation to problems of Œnothera genetics some years before Morgan and Muller in 1918 discussed the findings of balanced lethals in Drosophila. Renner deserves particular mention as an investigator quick to bring the facts of gametic and zygotic sterility into relation with the peculiarities of Œnothera breeding. As the result of his studies and those of other investigators we have reason to feel confident that most of the œnotheras that have been the subject of experimental study are impure species, that is to say, heterozygous in their genetical constitution.

I am, nevertheless, confident that pure species of Œnothera do exist but it will require much patience in observation, in cytological analysis, and in experimental crossing to establish them. The most promising form in my experience is a line of *Œnothera franciscana,* which has almost perfect pollen and produces seed about ninety per cent. viable. This line I have selfed for eight generations without finding a single departure from the type. The last generation, grown during the past summer, was a culture starting with 1,425 seedlings from seeds experimentally forced to complete germination, a germination percentage of 87.3 per cent. In this large culture 1,373 plants survived the vicissitudes of the season, a loss of only 52 plants mostly as seedlings. This culture was large enough to bring out variants if present in the proportions thrown by *Lamarckiana,* which for some variants is as high as one per cent., but the culture gave no exception to the type. Also, crosses have been made with *biennis, muricata* and *grandiflora* and, when *franciscana* was the pollen parent, the results have been uniform F_1 generations, indicating that the pollen grains of *franciscana* are all alike in genetical constitution. Finally, a cytological study of pollen formation now in progress by my former student R. E. Cleland shows a regular pairing of chromosomes during meiosis in contrast to the loose association of chromosomes characteristic of the same stage in *Lamarckiana* and such other œnotheras as have been studied with the exception of a race of *grandiflora.* Thus the evidence of high fertility, uniform progeny when selfed, uniform F_1 generations when used as the pollen parent, and regularity of chromosome pairing during meiosis all point to the genetic purity of this race of *Œnothera franciscana.* I present this line as the purest Œnothera material known and safer than the race of *grandiflora* that I selected twelve years ago and which satisfied fairly well the tests of a pure species except that it threw occasional weak dwarfs. This isolation of an apparently pure species of Œnothera is a matter of satisfaction and of some importance for the future of genetical studies in this group of plants since in the past we have had no standard material of unquestioned purity with which forms could be mated in tests of cross breeding. My apparently pure race of *Œnothera franciscana* is vigorous, easily grown in cool latitudes, and has a long flowering season, qualities important for experimental work, and I confidently offer it to students of Œnothera as a plant worthy of their attention.

The interpretation of the breeding behavior of *Œnothera Lamarckiana* on the hypothesis of its impure germinal constitution has received important and most substantial support from the investigations of Muller on material of Drosophila which led to his theory of balanced lethals. The condition of balanced lethals results when two different lethals are present, the first in one chromosome and the second in the other chromosome of a pair. Thus each lethal is present in a single dose and the genetical constitution is therefore heterozygous for each lethal but the two lethals are in different chromosomes of a synaptic pair. Since the lethals operate when in double doses close breeding in such a race will result in a succession of generations repeating the

heterozygous genetic formula because the homozygous associations of either lethal block further development. Such a factorial situation would maintain a state of constant heterozygosis, the fixed hybridism of an impure species. The genetical impurity will be passed from generation to generation and in this respect the hybrid will breed true until the relative positions of the lethals are changed by a crossover, or the genetical constitution in these respects is altered by a mutation. A crossover frees at once recessive characters which were suppressed by lethals in homozygous condition and the sudden appearance of such recessives will simulate mutations although in reality they are manifestations of a process of segregation.

The theory of balanced lethals offers such a satisfactory interpretation of the behavior of certain Drosophila material, behavior similar in nature to that of *Œnothera Lamarckiana,* that Muller was quick to suggest the application of his results to Œnothera problems. It should be noted that De Vries as early as 1911 offered a hypothesis essentially similar to the theory of balanced lethals to account for the peculiarities of the double reciprocal crosses between *Œnothera biennis* and *Œnothera muricata,* forms which, on strong evidence from the studies of Renner, we now believe to be impure species. Investigations of my own, published in 1917, on these hybrids and on others support the conclusions that lethals are common in Œnothera material, but I believe that conditions are more complex than indicated by the conclusions of De Vries and Renner. De Vries in recent papers has also made free use of lethals in offering hypotheses to cover certain results of his breeding studies with Œnothera.

Although it is not my purpose to discuss the mutation theory of De Vries it does seem important to examine critically the position of this theory as it is affected by the evidence for the existence of impure species that are held to a behavior of pure breeding or almost pure breeding by lethals which suppress the appearance of segregates. Lethals are not rare in Drosophila and Œnothera material. There is reason to suspect that they are common manifestations of irregularities in the mechanism of the organism of so serious a nature that they interfere with vital processes at some point in the life history, finally bringing the machine to a standstill with death as a result. The workers with Drosophila seem inclined to believe that much of the phenomena simulating mutation in their material is in reality the appearance of characters set free by the breaking of lethal adjustments which held the characters latent. Well known workers have arrived at similar conclusions for Œnothera material and are not content to accept as evidence of mutations the behavior of *Lamarckiana* and some other forms when they throw their marked variants.

An entirely new conception of mutation phenomena has grown up with meaning very different from that of the past. Œnothera material selected by De Vries on the assumption that it illustrated mutation in a pure species proves to be highly impure and in genetical constitution exceedingly complex. Progress in the study of mutations must follow the usual course in genetical research and rest upon intensive studies of particular characters, analyzed and traced through experimental cultures and tests of cross breeding, with the assistance of cytology at critical points in the life history, and with constant attention to phenomena of infertility and sterility. From the later writings of De Vries it would seem that the master recognizes the newer trend. Logically mutations appear to be more likely from hybrid stock than from pure lines since heterogeneity of germinal constitution obviously invites chemical and physical modifications that might lead to the origin of new genes or to such changes in old genes as would result in different expressions of former characteristics. Of particular import is the expectation that lethals most frequently owe their presence to heterozygous conditions since the mixing of diverse germ-plasms seems likely to lead to the breaking down of delicate and vital adjustments in proportions relative to the degrees of protoplasmic confusion, and this means chemical and physical disturbance. The intensive study of specific mutations with its effort at analysis to the last degree is a

very different matter from that care-free attitude of former years which permitted any marked variation not easily interpreted to pass as a mutation. Mutation has become intimately a part of that most fundamental and illusive problem of biology, the origin of variation, and mutations apart from the study of their causation are of secondary interest.

Œnothera material and lines of Drosophila were not the first representatives of impure species to be isolated by the geneticist. The blue Andalusian fowl which cannot be fixed, yellow mice that never have the double dose for yellow, Vilmorin's dwarf wheat which throws talls but fails to produce homozygous dwarfs, single stocks never homozygous for singleness, these and other cases are well known and proven examples of impure species heterozygous in their germinal constitution. Certain of them, as the blue Andalusian fowl, throw two homozygous types, in this case the black and white "wasters." Others produce one viable homozygous type. Some impure species rarely and perhaps never throw homozygous segregates. All agree in this respect that the heterozygote, which breeds true to its proportion of the progeny, can not be fixed by selective inbreeding although as an impure species it reproduces itself with exactness.

We have briefly reviewed conclusions from the intensive study under experimental conditions of lines which genetical investigations have established as representatives of impure species. Some of the material is obviously of the sort that would not hold its own under conditions of open competition in Nature, but much of it has been derived from forms not far removed from wild species. There is a broader aspect of the subject of the hybrid deserving of examination, namely, the study of the possibilities of the impure species as a definite component of faunas and floras.

First of all it is important to bear in mind that if we accept the current theory which places the determination of sex as a function of the reduction or segregation divisions, all unisexual animals are heterozygous for sex factors and for such genes as are responsible for sex-linked characters. For higher animals this means that either the male or female carries in single dose a chromosome which is not paired with an equivalent chromosome. For higher plants we should expect the diploid sporophyte generation to be heterozygous for sex determining chromosomes, a condition for which as yet we have cytological evidence from only one type, the liverwort Sphærocarpos studied by Allen and his students, although there is experimental evidence for this condition in other liverworts, in some unisexual mosses, and in certain seed plants, *e. g.*, Melandrium. The behavior of sex-linked characters may then be believed to follow an orderly system in inheritance except as such linkage is broken or as point mutations appear in sex chromosomes.

But accompanying the sex chromosomes are those groups of chromosomes, the autosomes, responsible for characters not of sex or sex-linked. The unisexual state precludes the possibility of that closest form of inbreeding possible through hermaphroditism and leaves the way open to outbreeding subject only to physiological limitations and to conditions whereby lethals prevent reproduction. That Nature has made extensive use of this encouragement of outbreeding in various degrees cannot be doubted, and this is best illustrated in man, the most mixed and varied of all animals in the assortment of genes carried by the individual. It is impossible to believe that any human is homozygous for the complex of factors responsible for his individuality.

Even when, as in most higher plants, the diploid sporophyte generation is bisexual, there have arisen in many lines of evolution conditions that make for very high degrees of genetic impurity. There was a time in the history of botany when workers, following the lead of Darwin, devoted themselves to the study of devices to secure cross-pollination and many and remarkable are the arrangements described to encourage outbreeding. Volumes have been written on this subject and the facts in general are freely admitted. In wind-pollinated forms there is even greater opportunity for promiscuous pollination unless the shedding of pollen takes place at such a time that stigmas are dusted and the ovules self fertilized before outside pollen has had an opportunity to reach

the pistil. Perhaps the best examples of wind pollinated types very freely open to outside pollination are the numerous races and forms that make up the collective species *Zea Mays*. The studies of East and Jones, Emerson, Shull, G. N. Collins and others, extending over many years, show conclusively that corn is usually a hybrid composite with so many characters represented by genes in single doses that purification of material by selective inbreeding is a matter of much time and patience. There could hardly be a greater contrast in genetical behavior than that between lines of wheat which, because they rarely outcross, breed very true, and races of corn that can only be kept reasonably true by constant watchfulness, practiced selection, and a never-ending elimination of products departing from the types.

Self-sterility and the production of weakened generations following inbreeding, as factors leading to the establishment of impure species, have not as yet received recognition proportionate to their importance. Genetical studies seem likely to show that there are large groups of bisexual plants the individuals of which are either infertile when selfed or produce progenies in successive generations distinctly inferior in vigor to the wild types. In such material the species represented in Nature must be very largely, if not wholly, made up of individuals cross-bred and genetically impure. It is significant that these conditions should have been found in that most successful assemblage, the Compositæ, frequently cited as the climax group of plant evolution. The recent studies of Stout on chicory have shown the extensive presence of self-sterility, and that the wild populations must consist chiefly of outbred and probably heterozygous individuals. Investigations of J. L. Collins on Crepis indicate that species of this genus are impure since progeny from selfed lines show marked deterioration from the wild stock as segregation proceeds and forms approaching purity of germinal constitution are isolated. Crepis seems likely to prove an assemblage of impure species similar to that assemblage of impure races called *Zea Mays*, and will probably show the same parallelism of behavior in reduced vigor and the production of abnormal types as inbred lines are separated from the wild population. The interpretation for Crepis is likely to be that of East and Jones for maize, namely, that inbreeding gives deleterious results through the segregation of types with fewer genes for characters associated with physiological vigor of expression. These studies are tending towards conclusions well established for many cultivated fruits, as apples, pears, plums, cherries, etc., where self-sterility among the varieties proves to be the rule and cross-pollination is necessary for sexual reproduction through impure lines. It is hardly possible that chicories and species of Crepis are outstanding exceptions to conditions in the Compositæ and we may safely predict that studies in this immense assemblage will reveal wide-spread the presence of impure species. Self-sterile lines among the grasses have also been reported, *e. g., Lolium perrene*.

There is another type of impure species not represented in the animal kingdom but common in certain groups of plants and therefore of particular interest to the botanist. This is the hybrid which perpetuates itself by vegetative means and thus establishes populations in the wild when its characters are favorable to survival under the scrutiny of natural selection. The well known principle of hybrid vigor, or heterosis, may in itself be expected to give to such hybrids marked advantage. These impure species hold true to their characters through asexual reproduction although by their seed they may produce a large variety of segregates. This principle of the maintainance of a hybrid by vegetative reproduction is applied in agriculture when selected lines of potatoes are propagated from slices of the tubers and strawberries from plants developed by the runners, and in fruit culture by the grafting of choice hybrid varieties.

There have been two notable systematic studies in America on groups of wild species in which hybrids are found well established as impure species. Brainerd's investigations on the violets and blackberries show the possibilities of critical studies on the status of species, making use of the experimental garden and basing results on genetical analyses. Favored

hybrid blackberries, spreading readily by prostrate branches that root at the tip, may easily establish themselves in extensive growths. In a recent classification of the blackberries of New England Brainerd and Peiterson isolate 23 hybrid species of the 12 primary species that are recognized, and they give an additional list of 32 suspected hybrids. Violets do not spread so prolifically as brambles but there are a number of hybrids known which maintain themselves in Nature by vegetative growths. Other groups of plants readily propagating from stems are likely to show similar proportions of impure species as they are more thoroughly studied.

With the data before us on the widespread occurrence in Nature of impure species we wonder what will be the reaction of systematic botany. It will be impossible for the manuals to include the many hundreds of lines which the geneticist may isolate as impure species although they may be definite units of floras. There will be little satisfaction in attempts to identify in the field races which can only be established by experimental studies of the garden. Are these impure species to be grouped for convenience as collective species regardless of their true positions and relationships? Truly the paths of the systematist and ecologist have not been made easier by the progress of genetics.

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THE TREND OF EARTH HISTORY[1]

II

Through the millions of years represented by the Tertiary period the mammals differentiated slowly along the conventional lines which had been previously marked out in large measure by the reptiles. Some became adapted to life on the dry plains, others in the forested river flats, others in the high mountains, the tree-tops and the tropical jungles. A few of them learned to fly more or less successfully, some burrowed under ground and still others became aquatic. In a general way they did what the various kinds of reptiles had done before them in the Mesozoic era, but, on the whole, they seem to have done it better.

Finally, about the end of the Tertiary period or later, the next great advance was made by the genus *Homo*—an offshoot of one of the most insignificant groups of mammals. In consequence of this achievement, the entire group has been dignified with the name of *Primates*. From this offshoot so many surprising things have developed that it is hard to say which one was fundamental. Undoubtedly, one of the first new habits of the human genus was the use of tools. We may reasonably suppose that only one of the less specialized types of mammals, a creature possessing flexible fingers and hence the power to grasp a stone or a club in the hand, could acquire such ability. Possibly it was this initial power that gave the first impetus to the higher progress of the pre-human stock. Be that as it may, the progress of the human race seems to have depended largely on the ability to invent and use other things, such as fur-covered skins for clothing, the spear and bow-and-arrow for the chase, the fish hook, the needle, the potter's wheel and so on through the long list of human contrivances. As Bergson has remarked, each human tool and machine serves as a new and additional bodily organ and so multiplies our functional activities to a wonderful degree. The development of higher intelligence went on side by side with this multiplication of inventions, doubtless, on the one hand, being stimulated by it and, on the other, making possible its continuation.

Looking back over the great contributions which the various animal groups have devised and elaborated in the vast stretches of geologic time, and omitting only that of the human race—which is too new to be impartially judged—it will be observed that, although each of these innovations has brought temporary success and domination to its holders, it has never been able to insure the permanency of the exalted position so attained. Experimentation seems to be nature's endless pastime. Her appetite for it is insatiable; and, no matter how interesting the results of the trials already made, there are always more to come. As John Burroughs once said, "Nature hits the mark, because she shoots in all directions."

In that part of the history of man which is sufficiently well known, we perceive a series of

subsidiary waves of rise, culmination and decline. Each race or nation seems to have its day in turn. The causes of such temporary rises are complex, but in each instance it appears that some new plan or system or way of doing things is tried out and its value, whether great or small, determined. Part of the new plan may prove to be good; it may be retained and adopted by succeeding dominant races. Other parts of the system prove faulty and eventually cause the downfall of the race. The injurious features are not likely to be copied by those that follow.

Without implying that the factors selected are the only ones, or even the most important ones, I may draw illustrations from the well-known histories of nations. The great expansion of wealth and domination among the ancient nations around the Mediterranean Sea was due to many and complex causes. Its industrial basis of energy was largely animal power—the labor of beasts of burden and of men. Expanding civilization created a demand for more and more power. To meet this demand slavery was increased to a point probably never equalled before or since. To-day we rely chiefly on fuel power and hence have been able to dispense with slavery, but in the days of Rome no other available source of energy was known. Metals were mined and smelted by slaves, ships were propelled by slaves, food crops were raised by slaves, and even the revenues of government were supplied in large measure by unwilling tribute from conquered tribes. For the master people this scheme produced wealth and power and enabled them to maintain control for centuries. It contained within itself, however, a fatal seed of weakness in the opposing self interests and disloyalty of the slaves. Given a good opportunity, both the oppressed tribe and the enslaved man were ready to overthrow their oppressors and make an end of them.

In the Chinese civilization, which has long dominated eastern Asia, one of the central influences seems to me to be ancestor worship. Other religions have been tolerated and partly adopted by the Chinese from time to time, but for the most part they have been merely grafted upon the ancient stem, forming non-essential modifications. The requirements of ancestor worship had many advantages. It is not hard to trace to this ancient and firmly held code much of the industry of the Chinese, their solid, steady qualities, strong family ties, admiration for personal achievement and culture, and their respect for authority. Yet ancestor worship has not proven an unmixed blessing. It has tied men each to his own locality. It has made for over-population with the attendant evils of poverty, ignorance and even starvation. Above all, it has turned the faces of the Chinese people towards the past and inspired them with little interest in the future. One may well regard this as one of the most potent factors in making China the backward nation she has been these many centuries.

The modern peoples of the Atlantic region—our so-called western nations—are now contributing to the museum of human experiments that system of living which may be called "Industrialism," whereby through machinery and extreme specialization of labor each member of society is multiplied in activity, wealth is produced and distributed at an unprecedented rate, new inventions follow each other with bewildering rapidity, and material "progress" is the watchword. Although this curve has probably not yet reached its culmination, its more serious defects have already revealed themselves. Life in the cities is becoming more and more artificial and unnatural. Physical degeneration of the most civilized nations is making headway. If carried out to its logical destiny, industrialism as a scheme of life will doubtless fail like its predecessors. There are plentful signs that this failure is not far off unless we develop and effectively apply wisdom enough to modify present dangerous tendencies before it is too late, and thus save the best of the system for still further advancement.

It would be strange if, from all we know concerning the past history of the earth and its inhabitants, we could not discern some general scheme or underlying principle which would help us to fit more successfully into our environment, and perhaps even to make a shrewd guess about the future—not of our-

selves as individuals, but of our remote descendants and the earth on which they are to live. It is obvious that a geologist is on safer ground if he confines his thoughts to the domain of geology; and there are some who may adopt the attitude that it is not fitting for him to digress from the pursuit of his strictly geological facts and theories. With that opinion I frankly disagree. It seems to me that there are times when the geologist should consider the relation of his own science not only to other sciences but to the affairs of his country and the world at large. I shall therefore venture to comment upon certain aspects of those relations which seem to me worth considering on such an occasion as this.

The old anthropocentric attitude of mind, which characterized even the more progressive nations up to very recent times and is still prevalent among humans in general, exaggerated the importance of man. All things were regarded as being intended for his use, benefit or punishment. The rain was sent to mature his crops; the forests covered the land in order that he might have wood; the fishes of the sea had been thoughtfully provided for his subsistence; and coal had been formed in the rocks to give him warmth and power. Within the last few decades this attitude has been supplanted to some extent by the evolutionary view, which had been incubated long before the time of Darwin, but was by his cogent marshalling of facts given great impetus in the world of philosophy. Even to-day this point of view is generally modified by a prejudice, which is understandably subtle in its appeal and extremely difficult to cast out. Many were disposed to accept the theory of evolution as applying to the ordinary plants and animals, but with reservations when it came to the genus Homo. Man was supposed somehow to be an exception, more or less exempt from those laws which had governed all organisms for hundreds of millions of years up to the time of his advent. It would be interesting to know how widely this view prevails to-day even among that minority of human kind who are considered well educated and philosophically minded. It is tacitly assumed in certain widely used text-books of geology, which were current within a score of years.

Unquestionably we do differ from all other animals in that some of us have learned to do things in a high degree which other animals do only in very low degree or not at all. The faculty of invention, which can be traced as a mere rudiment in some of the other mammals, we have developed in wonderful measure. Communication of thought by sound and gesture—a power possessed by many other mammals as well as birds—we have improved until we are able to communicate ideas accurately and in the finest shades of meaning by our vocal language. Many other animals remember their experiences and profit by such recollections, but it is the human species that has vastly increased the store of such remembered ideas and uses them as material for thought. Above all, man is the reasoning animal, fabricating new ideas out of present observations and the records of the memory. This is doubtless the greatest innovation presented to the world by the human species. Can we impartially estimate its value?

It has often been assumed that these wonderful powers of the mind are fast giving to the human race control over its environment to such an extent that henceforward many of the laws of evolution which have hitherto governed the careers of animals and plants will be abrogated or greatly modified, so far as concerns man. It has been supposed, in short, that we do or will effectively dominate other organisms and can readily adapt ourselves to those environmental factors, such as climate, which we cannot directly control.

In some measure this is true. We have lately become so accustomed to triumphing over the lower animals and circumventing the once impassable barriers of the oceans, the upper air, and the frozen polar regions, that it may be opportune to raise the question whether either domination or adaptation are destined to go as far as is commonly believed, and to what extent they are to last—for the geologist cannot regard anything as permanent. It is a truism among us that the only permanent thing in the universe is change.

In most parts of the world we have by this

time conquered wild beasts to such a degree that in the more civilized temperate zone countries we give no thought to them, although in some parts of India they are still a constant menace to the ordinary man. But at the other end of the biologic series are the much more numerous and more dangerous micro-organisms which assail us on every side. When all the circumstances are favorable we can now control insects, protozoans and bacteria, which are the carriers or causes of many of our most dreaded diseases. But it is a hard struggle to dominate such scourges as plague, typhus, cholera and yellow fever. They never sleep, and if, like Russia to-day, a nation finds itself temporarily unable to maintain the needed precautions, its boasted control soon vanishes.

We have learned to overcome the isolation of space on land and sea, to move about more rapidly than any other animal, to fly higher than any bird has ever gone, and to maintain summer heat in the coldest winters; but in order to do so and by virtue of this expansion of our activities, we are rapidly depleting the earth's storehouse of materials. We are assured by those who have most carefully studied the subject that the liquid energy of petroleum will not serve us adequately beyond this generation; copper for our wonderful electrical systems should last somewhat longer; and coal some centuries or even thousands of years. But what is ten thousand years in the life of a race? Other sources of energy are known and we may yet learn to use them profitably; but it is well to remember that the continuance of our type of civilization on anything like its present scale is absolutely contingent upon the success of such attempts. It is not merely a hope but a necessity, that should convince even the dullest mind of the need of incessant and extensive research with such objects in view.

We have organized manufacturing, trade and commerce to such an extent that millions of people may now be supported in towns and cities, and the average population per square mile multiplied far beyond what was possible only a few centuries ago. Through the application of science we have almost banished many diseases and have greatly reduced the usual death rate; and now we are hopefully attempting to do away with war. Yet these achievements can hardly be said to have rid us of our problems, for a crop of new ones has sprung up—the problems of the feeble-minded, the degenerate, the insane—to mention only a few of the most obvious. For the old diseases, many of which have been partly conquered, we have a great complementary increase in cancer, pneumonia and various functional and nervous ailments, which are aggravated by the crowding, the stress, intensity and sedentary nature of modern industrial life.

No doubt most of us believe that the algebraic sum of these gains and losses is a real advance toward a better state of things. Perhaps to question the lasting quality of this advance may not be so presumptuous as we usually have supposed.

The entire history, not only of the human race, but of its predecessors from the earliest known times, has been marked by constantly increasing complexity of bodily structure, function and activity. This increase has not been steady, but pulsating. Evidently we are to-day witnessing an acceleration of the normal increase in the complexity of human relations and action. As our modern civilization becomes more and more specialized and diversified, our relations to our environment become more and more complex and our adjustments more delicate. One thousand years ago, who cared whether economic depression prevailed in countries across the sea; yet in our present highly specialized condition such matters have risen to paramount importance. In the complexity of modern life wide-spread hardship and loss are caused by the temporary shutting down of a great electric system or by the closing of the coal mines; while a general railroad strike quickly brings on a paralysis of activity that can not be endured for more than a brief time without actual disaster. Yet one hundred years ago not one of these problems existed. They would have been difficult even to imagine.

The impetus of development seems always to carry the process of specialization onward without hesitation until a stage is finally

reached where it is impossible to go farther. Eventually it would seem that our western civilization should reach a point when its continued dominance would depend upon the effective working of all parts of a machine, grown far more extraordinarily complex even than we know it to-day. It is under just such conditions that slight changes of environment —using that term in its broadest sense—may most readily bring about the stoppage of the entire mechanism. In the hand-operated printing press used by Benjamin Franklin less than two centuries ago there was almost nothing to get out of order. Compare it with the highly complicated modern printing press which might cease to function if a single small screw or gear should fall out of place.

Furthermore, there seems to be a general tendency for development to go too far—to exceed the average capacity of the race at that stage of its evolution. Human history itself is full of illustrations of this principle. Many an ancient king of unusual executive and organizing ability has easily maintained a great empire during his own life-time. After his death, his responsibilities passed on to men of lesser ability, and the empire soon crumbled into as many petty states as before. The Greek Empire of Alexander and the Mongol Empire of Kublai are familiar examples. The greatest empire of ancient times, that of the Romans, was expanded beyond the dimensions which apparently were suited to that stage of human progress. Without the ready communication afforded by the modern telegraph and the efficient transport service of the railroad and the steamship, the highly developed administrative and military system of the Romans was strained beyond the limit of safety. It functioned for a time while conditions were favorable, but it was unable to survive much hostile pressure. No doubt the solution of many of Rome's problems is embodied in the modern British Empire. Thanks to the progress of civilization in the last few hundred years, the British have been able to maintain control over a far wider expanse of territory than any ancient empire.

To-day we see something of the same tendency at work in our huge industrial organizations, generally built up during the lifetime of one man and in large measure as a result of his exceptional ability. That more of these do not fail after the death of their organizers is due probably to our better system of democratic selection of successors trained under the master himself, whereby the ablest men are apt to be chosen. Nevertheless, it often happens that no one of sufficiently large caliber is available, and hence the enterprise suffers to a greater or less degree and in some cases drifts into disaster. There is some reason to think that our industrial, political and commercial undertakings are even now reaching a point where they are growing so vast, so difficult to handle, and requiring so high an order of ability at various points that they are becoming ineffective largely because a sufficient number of men of first-rate ability can not always be supplied. It is entirely conceivable that as this process becomes even more pronounced, the whole structure will in time collapse of its own weight on account of this factor.

Even if our own particular civilization does in time collapse and pass into the stream of history, like the careers of Greece and Rome, there is no apparent reason why other civilizations should not be slowly developed in its stead. It is probably safe to infer that such later civilizations will be founded on somewhat different principles, enabling these successors of ours to avoid some of the most serious difficulties with which we are now struggling. Perhaps they will achieve better success in those moral and social affairs, which are too often overlooked in our modern order. But there is no reason to suppose, however, that they will not make other mistakes just as disastrous, or in general that they will be exempt from the inexorable natural law which has brought about the ultimate decline of every previous civilization, each in its turn.

Eventually, after all the latent possibilities for advancement possessed by the human species have been exhausted, the race may conceivably sink back to the general level of the lower savages, which are but little above the

other mammals. In that state it could perhaps maintain itself for a long period of time, even though relegated to the less favorable parts of the world.

Without transcending the path already laid out in previous geologic periods, we may logically imagine also, that in due course of time —probably to be measured in millions of years, an entirely new and more highly organized animal may spring from some ancestral stock now relatively obscure, and rise, at first slowly and then more rapidly, to even greater heights of achievement than anything which lies within the capacity of the human species.

We have briefly examined the sequence of physical events in the earth's history and have found but scant indication of a definite trend toward an objective point. In the history of man and other organisms we seem to see, on the other hand, an evolution from the lower to the higher—from the simpler to the more complex. To that extent there has been quite evidently a general upward curve. It seems probable, however, that the quantity of organic life has remained more or less the same since very early times. There has been the age-long tendency for each species to multiply until its possible habitat was fully stocked with individuals. As periods came and went new types appeared and extended their realms, like wave-circles on the still surface of a pond, but compensating extinctions of older types left room for them. One may picture even the organic world as a stream, unchanging in volume, though ever changing in composition; and its end is to us still as invisible as its beginning.

ELIOT BLACKWELDER
HARVARD UNIVERSITY

THE AGRICULTURAL MUSEUM OF THE ARGENTINE RURAL SOCIETY

MUSEUMS devoted strictly to agriculture are rare. The only one in the Western Hemisphere, founded and organized as such, is located in the metropolis of the Argentine Republic. An illustrated pamphlet of fifty pages describing the museum and briefly outlining its collections has been published[1]. It is in a series of publications issued by the museum, and forms the basis of this communication.

Argentina is preeminently an agricultural country. More than half its cultivated area, 64,225,000 acres, is devoted to the growth of wheat, Indian corn, oats and flax (for seed). Its vineyards occupy 345,800 acres while 24,700,000 acres are in alfalfa. Cattle and other domestic animals number about 92,300,000 and in 1918 Argentina exported 1,479,618,000 pounds of meat.

The collections made to illustrate the agricultural resources of the country at the centennial exposition, held in Buenos Aires in 1910, were so extensive and valuable that a permanent museum was established in which to preserve them. The success which has attended the foundation and organization of the museum is due chiefly to the foresight and untiring energy of Sr. Carlos D. Girola, agricultural engineer, who has been its honorary director from its origin. He has built up, without guide or precedent, an institution of the greatest value in promoting the agricultural interests of his country. The museum now contains more than 30,000 specimens, covering the entire field of agriculture and is one of the most comprehensive of its type in the world.

The collections are classified in seven groups or divisions as follows:

1. *Natural Products,* such as woods, native medicinal and forage plants, minerals, soils, mineral waters, etc.
2. *Agricultural Products,* including everything produced on the farm such as wheat and other cereals, vegetables, narcotic and aromatic plants, fiber plants, etc. In this group the museum contains 6,000 specimens.
3. *Products of Animal Origin,* wool, hides, leather, etc.
4. *Products of Agricultural Industry,* flour, sugar, tannin, dried and canned fruits and vegetables, etc.
5. *Products of Animal Industry,* milk, butter, cheese, bees and bee products, poultry and

[1] Museo Agricola de la Sociedad Rural Argentina "Fundacion Organizacion Muestrarios," Ing. Agr., Carlos D. Girola 1910-Director Honorario-1921. Publicacion Museo Agricola S. R. A. No. 25.

poultry products, silk culture, game, fish, diseases of animals, etc.

6. *Agricultural Machinery,* tools and appliances used in agriculture.

7. *Rural Engineering,* under which are placed all subjects relating to farm buildings, construction of granaries, etc.

In the organization of the museum provision is made for the holding of agricultural congresses or meetings for the purpose of discussing subjects relating to agriculture, and for the issuing of publications and making exchanges. Up to the present time the publications include twenty-five titles, most of which have been prepared by Sr. Girola. Among the subjects treated are: "Studies of Cotton," "Observations on samples of wheat from the Territory of Pampa," "The Cultivation of Wheat in Argentina," "Spineless Cactus," "Cultivation of Flax in Argentina," "Cultivation of Indian Corn in Argentina," "Notes on Argentine Fruit Culture," etc. For the most part these papers are based on the collections of the museum.

The supervision of this museum is under the directors of the Argentine Rural Society. The museum staff consists of the honorary director, curator, assistant curator and two caretakers. The museum building is located on the grounds of the Rural Society, in a very attractive section of Buenos Aires, overlooking Plaza Italia. It is 300 feet long by 90 feet wide and originally cost $100,000.00. The interior which is well lighted, consists of a main floor surrounded by a broad balcony.

The annual attendance at the museum, which is open to the public two days each week, exceeds 100,000 not including the 30,000 students which visit it from the schools of Buenos Aires. These figures demonstrate the interest which the museum has aroused and the need for such an institution.

The illustrations in the pamphlet before us include the museum building, its floor plan and twenty full page views of the interior, showing many of the exhibits and the manner in which they are installed. The collections have far outgrown their present accommodations, and plans have been prepared for additional building to take care of the agricultural machinery and other new material.

Besides the agricultural museum at Buenos Aires there are the Danish Agricultural Museum at Lyngby, near Copenhagen, established in 1888; the Agricultural Museum at Petrograd, about which little is known at the present time; the large and well-equipped museum at Berlin, and the attractively located and wonderfully interesting museum at Budapest. The buildings of this museum at Budapest, constructed at a cost of $480,000.00, are so designed as to illustrate the Renaissance and medieval periods of architecture of Hungary. Their interiors are superbly finished, and the collections, which may be said to include the agricultural features of museums of art, history and anthropology, natural history and commerce, are appropriately and beautifully installed in the many well-lighted rooms into which the Renaissance and Gothic buildings are divided.

The museum at Buenos Aires should not be compared with those institutions which have been built and liberally supported by the state. Great riches are not indispensable. An agricultural museum properly located for meeting its purposes would, by well directed effort and with the friendly cooperation of those engaged in agricultural industries, quickly secure collections. With such collaboration an equipment may be acquired that will equal or possibly excel in practical importance that which money could buy.

Like Argentina in South America, Hungary in Europe is essentially an agricultural country, and it is interesting to note that in the one case the material and exhibits that formed the basis of its collections were assembled for an exposition commemorating the hundredth anniversary of the country's existence as a nation—in the other instance the collections commemorated its thousandth anniversary, the National Millennial Exposition held at Budapest in 1904. Our hundredth anniversary, commemorated by the exposition held at Philadelphia in 1876, has passed. Argentina has outstripped us in its agricultural development by the establishment of a permanent agricultural museum. Without any reflection upon the progress and present status of agriculture in Hungary, which is most commendable, let us hasten to follow the example of our sister Republic in South America

and not wait for our milennial anniversary before establishing a great American Museum of Agriculture.

F. LAMSON-SCRIBNER

WASHINGTON, D. C.
OCTOBER 21, 1921

SCIENTIFIC EVENTS

THE WILLIAM BARTON ROGERS SCIENCE HALL OF THE COLLEGE OF WILLIAM AND MARY

AN advisory committee of prominent men, most of whom are trustees or alumni of the Massachusetts Institute of Technology, has been formed in the interests of a movement to provide for the erection at the College of William and Mary, in Virginia, of the William Barton Rogers Memorial Science Hall, in honor of the William and Mary graduate who founded the Massachusetts Institute of Technology.

The members of the committee are T. Coleman DuPont, Wilmington, Del., Charles W. Eliot, Cambridge, Mass.; Samuel Morse Felton, Chicago, Ill.; Francis Russell Hart, Boston, Mass.; Charles Hayden, New York, N. Y.; Otto H. Kahn, New York, N. Y.; Hugh MacRae, Wilmington, N. C.; Eliakim Hastings Moore, Chicago, Ill.; James P. Munroe, Boston, Mass.; Henry Smith Pritchett, New York, N. Y.; Charles Augustus Stone, New York, N. Y.; Gerard Swope, New York, N. Y.; Elihu Thomson, Swampscott, Mass.; Charles Doolittle Walcott, Washington, D. C.; Edwin Sibley Webster, Boston, Mass.

The College of William and Mary is the second oldest college in the United States, yielding only to Harvard University in this respect. President Harding, on a visit to the college on October 19 last, in company with Secretaries Hughes, Hoover, Mellon and Weeks, of his cabinet, was greatly impressed with the traditions and present progress of the venerable institution. He referred to the college as 'the Spartan of American universities," having in mind, no doubt, the successful effort of William and Mary to endure after its burning in the Civil War, in 1862, shortly after Dr. Rogers had established in Boston the great technical school.

William Barton Rogers was one of four brothers, who were educated at William and Mary, each in later life achieving great distinction in a chosen field of science. He, himself, as a geologist, was noted in Virginia long before he went to Boston. He was the introducer of the laboratory method of teaching science in this country, according to Dr. Charles W. Eliot, who was one of his original faculty at the Institute of Technology. The three other brothers were Henry D. Rogers, who became regius professor of natural history in the University of Glasgow, Scotland; James Blythe Rogers, professor of chemistry in the University of Pennsylvania; and Robert Empie Rogers, professor of toxicology in the Jefferson Medical College of Philadelphia.

The sum of $200,000 has been set as the amount needed for building the Science Hall, which is designed to commemorate the bond of friendship between the South's oldest college and the North's foremost institution of technology. Contributions may be sent to E. B. Thomas, alumni director, 331 Madison Avenue, New York City.

RETIREMENT OF PROFESSOR ALBERT W. SMITH OF CORNELL UNIVERSITY

THE following minute has been adopted by the University Faculty of Cornell University on the occasion of the retirement of Professor Albert W. Smith:

In the retirement from his academic functions of Albert William Smith, dean of Sibley College and acting president of the university, this faculty suffers a heavy loss. Few have been so universally, so deeply, so deservedly loved. An alumnus of Cornell in the first decade of her career, he was from early in his undergraduate days a leader both in study and in manly sports, and one whom his fellows delighted to honor. Returning to Cornell in 1886 for graduate study, he was not again suffered to depart from academic life. From 1887 to 1891 he taught engineering at Cornell, in 1891-1892 at the University of Wisconsin, from 1892 to 1904 was head of the work in mechanical engineering at Stanford. Since 1904, when he was called back to Cornell to succeed Dr. Thurston in the headship of Sibley College, he has remained with his alma mater, adding to his directorship the chair of power engineering; and in 1920, at the retirement of Dr. Schurman, he became acting president of the university.

With what loyalty and efficiency he has dis-

charged these functions is known to us all. As an engineer he has stood high in his profession, and, in conformity with a principle which he has urged on his colleagues, he has never allowed himself to fall out of touch with its practical side. As a teacher and a writer on technical subjects he has had the power to make intelligible and clear the abstrusest of problems, and outside the class room he has not lost touch with his pupils. As an administrator even his colleagues know his promptitude, his patience, his considerateness, his remarkable sympathy with the students.

But behind and above all these activities has been to us ever the loftiness of his character and the exceptional breadth of his culture. He has been not more engineer than poet; and his love of literature, his sensitiveness to art, his fine ethical enthusiasm, his rare modesty and courtesy, have set their mark on all his work, on all his views. In his teaching there has been nothing of the pedagogue, in his administration nothing of the martinet. We shall remember him, as do his students, primarily as man, as friend; and, while we lose him with regret, we rejoice with him in the new freedom to which he brings such rich resources.

THE AMERICAN SCHOOL OF PREHISTORIC STUDIES IN FRANCE

THIS school enters on its second year of activity in July, 1922, under the joint auspices of the Archeological Institute of America and the American Anthropological Association. It makes its appeal for students on the same footing as the American schools at Athens, Rome, Jerusalem and Santa Fé.

Both men and women are admitted either for the period of one year or for a shorter one. The work is divided into three parts: excavations in a Paleolithic site given the school by Dr. Henri-Martin, of Paris, to last about three months; excursions in fall and spring to the most famous caves, rock-shelters and neolithic sites of France. These include the Dordogne, the Pyrenees and the megaliths of Brittany. The last six months or so of work in Paris include lectures freely offered by the Ecole d'Anthropologie, museum excursions under the lead of the director of the school and library research.

For those who enter for the whole year, two scholarships are offered for competition, one of five thousand and one of two thousand francs; the former will suffice to keep a student through the year in France, if he can pay his way thither and back. There may be established a small loan fund, and there are occasional opportunities of earning money abroad while continuing work, but this method is not advised. At the end of the year a certificate is awarded, and a thesis should be written and presented by the student.

The excavations have this advantage that the students get into the ground themselves and do their own picking, for it is this rather than digging. Their duty is to learn what they are looking for and to understand it when found.

Flint implements, bones of the reindeer, horse, bison and mammoth occur, and many of them bear marks of contemporary work with flint implements; this is rather a "specialty" of the site of La Quina, where the American site is situated.

It is hoped that many will take advantage of this offer, and apply for entry to the school. All such applications as well as those for the scholarships should be sent as soon as possible to

CHARLES PEABODY
CHAIRMAN OF THE GOVERNING BOARD,
PEABODY MUSEUM OF HARVARD UNIVERSITY,
CAMBRIDGE, MASSACHUSETTS

THE HISTORY OF SCIENCE AT THE ST. LOUIS MEETING OF THE AMERICAN HISTORICAL ASSOCIATION

FOR the third consecutive year the subject of the history of science received the attention of the members of the American Historical Association at their recent annual meeting at St. Louis. The session especially devoted to the subject took the form of a luncheon conference at which Professor Lynn Thorndike of Western Reserve University presided. Interesting informal addresses were given by Professor James H. Breasted, director of the Haskell Oriental Museum of the University of Chicago, on the state of research concerning the science of ancient Egypt; by Professor Charles H. Haskins, of Harvard University, on the opportunities for research in the history of

science in European libraries; and by Professor Archer B. Hulbert, of Colorado College, on American history and the natural sciences. Further discussion followed, and it was proposed that the association establish a committee to facilitate the photographing of material in European manuscripts for the use of investigators in this country. The question was also raised of the relations between the American Association for the Advancement of Science and the Historical Association. The fact that this year the two bodies are to meet, respectively, at Boston and New Haven should provide the opportunity for a joint session or sessions on the history of science and perhaps for future common action or cooperation.

Papers of interest to students of the history of science also were read at other sessions at St. Louis. At the conference in Medieval History Professor Louis J. Paetow, of the University of California, treated of "The Twelfth and Thirteenth Centuries in the History of Culture," and Professor Lynn Thorndike, of "Guido Bonatti, an Astrologer of the Thirteenth Century mentioned by Dante," while at the conference on the History of Civilization Professor Breasted gave an account of the new Edwin Smith Medical Papyrus.

REPORT ON MEMBERSHIP OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE following tabulations present the status of membership in the association at the ends of the fiscal years 1920 and 1921, and on January 14, 1922. The tabulation for 1920 is incomplete on account of incomplete records, the present system of records not having been installed till the spring of 1920.

	At end of fiscal year 1920 (Sept. 30, 1920)	At end of fiscal year 1921 (Sept. 30, 1921)
Active life and sustaining members	353	349
Annual members in good standing	9,649	9,811
Total of members in good standing	10,002	10,160
Members in arrears for one year	993	682
Members in arrears for two years	447	705
Total of members on roll	11,442	11,547

Loss in membership during the fiscal year:	
Dropped at beginning of fiscal year (more than two years in arrears[1])	447
By death	44
By resignation	326
Total loss	817
Total gain in membership (new members):	
Sustaining members	1
Life members	11
Annual members	910
Total gain	922
Net gain in membership	105
Loss from October 1, 1921, to January 14, 1922:	
Dropped October 1, 1921	705
By death	46
By resignation	220
Total loss	971
Gain from October 1, 1921, to January 14, 1922:	
Reinstatements	16
New life members	11
New annual members	870
Total gain	897
Net loss from October 1, 1921, to January 14, 1922	74
Total of members on roll January 14, 1922 (11,547 less 74)	11,473
Total of members in good standing January 14, 1922	8,381
Associates for the second Toronto meeting (not included above)	247

It is to be noted that there were 158 more members in good standing on September 30, 1921, than there were on the preceding September 30, and that the total enrollment was greater on the latter date by 105. The total enrollment suffered a sudden decrease (of 705) on October 1, 1921, by the dropping of the names of all whose period of arrearage became over two years on that date, and this loss has since been increased, by deaths and resignations, to 971. To offset this, 881 new members were enrolled up to January 14, and 16 members were reinstated.

It is gratifying to note that the annual dues have been paid much more promptly this year than ever before. Of the 11,473 individuals whose names were on the roll January 14, 8,381 had paid their dues for the current year and were therefore in good standing.

BURTON E. LIVINGSTON,
Permanent Secretary.

[1] As provided in By-Laws, Article X.

SCIENTIFIC NOTES AND NEWS

The Rockefeller Institute for Medical Research on January 20 celebrated the twentieth anniversary of its foundation with a reception at which brief speeches were made by Mr. John D. Rockefeller, Jr., of the Board of Trustees, and Dr. William H. Welch, of the Board of Scientific Directors.

Dr. Henry C. Cowles, of the University of Chicago, was elected president of the Botanical Society of America at the Toronto meeting.

Dr. Hugh M. Smith, who has been United States commissioner of fisheries since 1913, has tendered his resignation. Mr. Herbert Hoover, secretary of commerce, has written to Dr. Smith: "I believe your service for thirty-six years, rising from the bottom to the top, in one of our great scientific bureaus, is unique in the history of the government. The whole country is under an obligation to you for so long and faithful a service."

British New Year honors include knighthood conferred on Professor C. S. Sherrington, president of the Royal Society and of the British Association and on Professor W. A. Herdman, recently president of the British Association.

Emmanuel De Margerie, Strasbourg, director of the Geological Survey of Alsace, has been elected correspondent of the Geological Society of America.

Mme. Curie, having been proposed for membership in the French Academy of Medicine, the academy, which has hitherto included no woman, has voted that she is eligible, and it is expected that she will be elected at the next meeting.

Dr. N. Antoni, of Stockholm, has been awarded the Lennalm prize for 1921 by the Swedish Association. He is the author of a number of works on clinical neurology.

The Paris Academy of Sciences has awarded to M. Georges Claude the Le Conte prize, amounting to 50,000 francs, for his discoveries in the field of industrial chemistry. M. Claude, in a letter expressing his gratitude, announces that he has decided to divide the amount of the prize between the Société de secours des amis de la science and the research laboratories of the Collège de France.

Dr. Albert Hassall, of the Zoological Division of the Bureau of Animal Industry, has been awarded the Steel Memorial Medal for 1921 by the Council of the Royal College of Veterinary Surgeons. Dr. Hassall has been in the Bureau of Animal Industry for the last thirty-five years, and in the course of that time, in addition to publishing numerous papers on parasitology, has built up a complete index catalogue of medical and veterinary zoology.

Dr. A. G. Ireland, associate professor of hygiene and public health at the University of Kentucky, has been appointed state supervisor of physical education and health by the Connecticut State Board of Education.

Dr. Frank P. Eldred, for twenty years director of the scientific division of Eli Lilly and Company, of Indianapolis, has resigned to engage in consulting work.

Warren R. Sholes, of the School of Mines, University of Utah, has received an appointment as mineral examiner in the Utah field division of the United States Land Office.

Dr. Robert N. Nye, former research assistant to Dr. Frank B. Mallory, has been made assistant director of the division of biologic laboratories of the Massachusetts State Department of Public Health.

Mr. S. Kruse, associate electrical engineer at the Bureau of Standards, who has been engaged in radio development work at the bureau, has been granted a year's leave of absence and has accepted a position with the Hammond Radio Research Corporation, Gloucester, Massachusetts.

Professor Ralph S. Hosmer, of Cornell University, who has been studying forest conditions in Europe, is returning to the University.

Fred P. Baker, for the past year and a half assistant director of the Boston station of the school of chemical engineering practice of the

Massachusetts Institute of Technology, has resigned to accept a position with the Proctor and Gamble Company, Cincinnati, Ohio.

Dr. Raymond W. Woodward has resigned as physicist and chief of the section of mechanical metallurgy of the Bureau of Standards, to become chief metallurgist for the Whitney Manufacturing Company of Hartford, Connecticut.

During December, Dr. George Joannovich, professor of pathological anatomy, and Dr. Radenko Stankovich, professor of internal medicine of the medical school of the University of Belgrade, paid a visit to London as guests of the Rockefeller Foundation. They had previously made an extensive tour in Canada and the United States, studying methods of medical education and public health administration.

The course of three Stewart lectures was given in November before the University of Melbourne on "The Modern Psychology," by Dr. R. J. A. Berry, professor of anatomy in the university.

Captain Roald Amundsen visited the Department of Terrestrial Magnetism of the Carnegie Institution of Washington on January 16, in order to complete arrangements with regard to cooperative work in terrestrial magnetism and atmospheric electricity between the Department and his forthcoming expedition to the Arctic regions. During the Northeast Passage, 1918-1921, the Amundsen Expedition made a series of highly valuable magnetic observations at somewhat over 50 different points. Captain Amundsen's chief scientific assistant, Dr. H. U. Sverdrup, has been associated with the Department of Terrestrial Magnetism since last October in order to complete the reduction and publication of the magnetic observations thus far obtained by the expedition. He will rejoin the *Maud,* Captain Amundsen's vessel, early in March at Seattle. It is expected that Captain Amundsen will resume his Arctic expedition about June 1. During his brief stay in Washington, Captain Amundsen also paid a visit to the non-magnetic ship *Carnegie.* In the evening he met at the Cosmos Club a number of the scientific men of Washington with whom he discussed the plans of his Arctic expedition, the chief object of which is to obtain scientific data relating to geography, oceanography, meteorology, gravity, terrestrial magnetism and atmospheric electricity.

The annual meeting of the British Association will be held in the university buildings at Glasgow on July 21-28 next. The first three days of the meeting will be taken up by the annual representative meeting, and in the evening of July 25 the president, Sir William Macewen, will deliver his address. Presidents of sections are: Medicine, Professor T. K. Munro (Glasgow); Surgery, Professor Alexis Thomson (Edinburgh); Pathology, Professor Robert Muir (Glasgow); Ophthalmology, Mr. A. S. Percival (Newcastle-on-Tyne); Neurology and Psychological Medicine, Dr. George M. Robertson (Edinburgh); Obstetrics and Gynæcology, Professor Ewen J. Maclean (Cardiff); Microbiology (including Bacteriology), Dr. R. M. Buchanan (Glasgow); Diseases of Children, Sir Herbert F. Waterhouse (London); Public Health, Dr. A. K. Chalmers (Glasgow); Physiology, Professor J. A. McWilliam (Aberdeen); Dermatology, Dr. Leslie Roberts (Liverpool).

At the last ordinary scientific meeting of the Chemical Society, London, held on January 19, Professor Arthur Smithells gave an account of Dr. Langmuir's theory of atomic structure, and exhibited models. Sir Ernest Rutherford's lecture on "Artificial Disintegration of Elements" will be given on February 9.

Dr. Ludwik Silberstein of the Research Laboratory, Eastman Kodak Company, lectured before the Franklin Institute on Thursday evening, January 26, on "An optical experiment in connection with the rotation of the earth."

During the week of January 9, Dr. H. H. Love, of the Department of Plant Breeding of Cornell University, delivered a series of lectures before the faculty of the School of Agriculture of the Pennsylvania State College on the importance of biometrical methods in interpreting experimental results.

Professor Edgar James Swift, head of the department of psychology and education in Washington University, gave an address on "The psychology of testimony and rumor" at the Naval War College, Newport, R. I., on January 26.

The annual meeting of the Society of Heating and Ventilating Engineers was held at the Hotel Pennsylvania from January 24 to 26. Among the papers presented were: "The Control of Blower Motors", by Henry H. Issertel, and "The Underfeed Stoker," by Frank A. De Boos.

The Mathematics Club of the University of Southern California, which the late Professor Paul Arnold helped to found, proposes to establish as a memorial to him the Paul Arnold Library of Mathematics.

A committee has been formed with Mrs. Mary K. Bryan, of the Bureau of Plant Industry, as chairman, to establish a memorial to Miss Eunice R. Oberly, librarian of the bureau from 1808 until her death on November 5. It is planned that the money given by her friends shall be used to establish a prize to be awarded for the work in which Miss Oberly was interested.

Sir German Sims Woodhead, professor of pathology in the University of Cambridge, died on December 29, at the age of sixty-six years.

Dr. Reginald Farrar, of Harrow, England, died on December 29, of typhus fever at Moscow, whither he had gone to assist Dr. Nansen in organizing arrangements for famine relief in Russia, under the auspices of the League of Nations and the League of Red Cross Societies.

Dr. George Stewardson Brady, F. R. S., who died at Sheffield on December 25, in his ninetieth year, was engaged in the practice of medicine and in 1875 became professor of natural history at Armstrong College, Newcastle, retiring as professor emeritus in 1906. He had done much useful work on the material gathered by the *Challenger* Expedition, having published reports on the ostracoda and copepoda. He also wrote a monograph of the free and semi-parasitic copepoda of the British Islands, and collaborated in a monograph of the ostracoda of the North Atlantic and Northwestern Europe.

The annual joint meeting of the American Geographical Society and the Association of American Geographers will be held in New York City on April 28 and 29. The program will be published about April 1. All interested are invited to attend the sessions to be held at the building of the American Geographical Society.

The Royal Institute of Public Health will hold a congress in Plymouth from May 31 to June 5. In addition to conferences on various matters there will be four sections: (1) state medicine and municipal hygiene; (2) naval, military and air; (3) bacteriology and biochemistry; (4) women and public health. The Harben lectures will be given during the meeting by Dr. T. Madsen, director of the State Serum Institute, Copenhagen.

The thirteenth annual meeting of the Paleontological Society was held at Amherst, Mass., from December 28 to 30, as the guest of Amherst College, in affiliation with the Geological Society of America. The special meetings of the society were held in the Geology-Biology building, while the members were comfortably lodged in the fraternity houses on the campus. Seven new members were elected at the meeting, making the membership at the end of 1921 total 214. The officers elected for 1922 were as follows: *President,* W. D. Matthew, New York City; *First Vice-President,* E. S. Riggs, Chicago, Illinois; *Second Vice-President,* E. W. Berry, Baltimore, Maryland; *Third Vice-President,* B. L. Clark, Berkeley, California; *Secretary,* R. S. Bassler, Washington, D. C.; *Treasurer,* Richard S. Lull, New Haven, Connecticut; *Editor,* Walter Granger, New York

The Russian Academic Group held its first annual meeting on January 12. The group consists of scientific men and women from Russia living in the United States. They have organized with the purpose (1) of studying the social, economic and industrial problems involved in the further development of Rus-

sia; (2) of effecting a closer contact between scientific and educational institutions of America and Russia, and (3) especially of helping the reconstruction of the academic life of the Russian universities and bringing relief to their members.

A LETTER has been received from the Attorney-General of the United States by the University of Chicago in appreciation of Professor Henry C. Cowles, of the department of botany, for his ecological investigations along the Red River for use in connection with a suit between the states of Oklahoma and Texas in the Supreme Court of the United States. "Dr. Cowles' investigations and testimony," the letter states, "have been of great value to the government, and, I am informed, to the cause of science in that they bring to the aid of engineering and physiographic investigations the comparatively new science of ecology, whereby the approximate time of the occurrence of changes in rivers, their flood plains and banks, is now definitely determined."

UNIVERSITY AND EDUCATIONAL NOTES

IN addition to previous gifts to the building fund totalling $800,000, Mr. Samuel Mather, of Cleveland, has announced to the trustees of Western Reserve University that he will provide funds for the erection of the new building of the School of Medicine. The estimated cost of the school building is $1,910,000, of the animal house $93,500, of the power house $473,000, and of connecting tunnels $53,700, totalling $2,529,700. Plans and specifications are complete and construction will begin in the near future. The medical school building is the first of a group, to be followed by the construction of the Children's Hospital, the Maternity Hospital and the Lakeside Hospital, all of which are affiliated with the School of Medicine. The entire group will be situated on the university campus.

A BEQUEST of $150,000 to Wesleyan University is contained in the will of Mrs. Dexter Smith of Springfield, Mass. The money will be available either towards erection of a new library building or for the general endowment fund at discretion of the trustees.

E. I. DU PONT DE NEMOURS AND COMPANY have authorized the continuance of the du Pont chemical fellowships of the total value of $15,000 in twenty colleges and universities throughout the United States for the academic year of 1922-3. The fellowships are for post-graduate work.

MORLAND KING, who went to Lafayette College last year from Union College as associate professor of electrical engineering, has been made professor and head of the electrical engineering department.

A. L. PITMAN has been appointed assistant director of the Bangor Station of the Massachusetts Institute of Technology's school of chemical engineering practice.

H. R. THEALTON, lately with Stone & Webster in Boston, has been appointed assistant professor of engineering at Dalhousie University, Halifax, Canada.

DR. R. H. ADERS PLIMMER has been appointed by the senate of London University to the university chair of chemistry, tenable at St. Thomas's Hospital Medical School, beginning with the new year. At present he is head of the biochemical department of the Rowett Research Institute at the University of Aberdeen.

DISCUSSION AND CORRESPONDENCE

ABRAHAM COWLEY AND THE AGRICULTURAL COLLEGE

I HAVE recently come upon a very interesting piece of history relating to agricultural education, while re-reading the essays of Abraham Cowley. The paper on agriculture in volume II of the 1707-1712 edition of his works contains one of the first recorded recommendations that I can find regarding the organization of agricultural colleges. In that essay he has the following to say:

> Did ever a father provide a tutor for his son to instruct him betimes in the nature and improvements of that land which he intended to leave him? . . . I could wish (but can not in

these times much hope to see it) that one college in each University were erected, and appropriated to this study, as well as there are to Medicine, and the Civil Law. There would be no need of making a body of scholars and fellows, with certain endowments as in other colleges. It would suffice, if after the manner of Halls in Oxford, there were only four professors constituted (for it would be too much work for only one Master, or principal as they call him there) to teach these four parts of it. First *Aration*, and all things relating to it. Second, *Pasturage*. Thirdly, *Gardens, Orchards, Vineyards*, and *Woods*. Fourthly, All parts of *Rural Œconomy*, which would contain the government of Bees, Swine, Poultry, Decoys, Ponds, etc., and all that which Varro calls Villaticas Pastiones, together with the sports of the field and the Domestical Conservation and uses of all that is brought in by Industry abroad. The business of these Professors should be . . . to instruct their pupils in the whole method and course of this study, which might be run through perhaps with diligence in a year or two.

The above essay was written about the year 1659 to 1665, and it is very interesting to note that till more than a century after, in 1796, was a Department of Rural Economy organized at Oxford, and Professor John Sibforth elected to be the first head of the department. We do not find references to agricultural colleges again, however, till the beginning of the nineteenth century. It will therefore be observed that Cowley was distinctly in advance of his times. Bacon had suggested schools for experimental research, but did not suggest the idea of an agricultural college. We do unquestionably notice Bacon's influence on Cowley in many respects, and especially in his "Proposition for the Advancement of Experimental Philosophy." In the organization of the Royal Society in 1662, Cowley evidently saw a partial realization of his philosophy as outlined in the "Proposition," and he became one of the original members of the society.

Heretofore we have known Cowley the poet and Cowley the essayist, but he has not before been known as Cowley the scientist, and Cowley the educator. A modern critic has said of him that he had "delicacy of feeling and unfeigned enthusiasm for the nobler and purer joys of life, for great literature, friendship, science, and nature." In this fair estimate by Dr. Gough, we have Cowley the *scientist*, as well as the *poet* and *essayist*.

In reviewing the early agricultural literature, I find references to a "Colledge of Experiments," by Gabriel Plattes in 1639, and "An Essay for Advancement of Husbandry Learning: or Proposition for the erecting Colledge of Husbandry, etc.," by Samuel Hartlib in 1651. In this last the writer had no such clear conception of the proposition as Cowley had. Adolphus Speed in his essay "Adam out of Eden," 1659, suggests "Diverse excellent Experiments Touching the Advancement of Husbandry."

If the readers of SCIENCE have more detailed information on this matter I should like them to offer it to the public through these columns. A study of these books on English husbandry has renewed my interest in Cato, Varro and Columella on Ancient Husbandry, and I, for one, would like to see these valuable treatises on agriculture brought out in such a series as the Loeb Classical Library.

R. J. H. DELOACH
THE ARMOUR CORPORATIONS,
CHICAGO

THE LOST FOXHALL JAW; ROBERT HANHAM COLLYER

Since the note concerning Dr. Collyer printed in the issue of SCIENCE for January 20 was written, the records of the Berkshire Medical College have been searched and they indicate that Dr. Collyer was not of American birth, as supposed by Mr. J. Reid Moir and the writer, but of English birth, inasmuch as the registration entry is: "To the President and Professors of the Berkshire Medical College. This Thesis [on the Progression of Animal Life] is respectfully dedicated by R. H. Collyer, A.B.—of the Isle of Jersey, British Channel, Pittsfield, Massachusetts, November 1st, 1839." This registration renders it unlikely that further records of Dr. Collyer himself will be found in the United States. Mr. Moir is now searching the British university records, also the records of the Isle of Jersey. In the forthcoming number of *Natural History* (November-December) appears a full account of Dr. Collyer's discovery.

HENRY FAIRFIELD OSBORN

JANUARY 16, 1922

THE RUSSIAN BUREAU OF APPLIED BOTANY

TO THE EDITOR OF SCIENCE: It might be of interest to the American scientific workers, engaged along agricultural and botanical lines, to know that Professor N. I. Vavilov, director of the Bureau of Applied Botany of Petrograd, Russia, who recently visited this country, has established a permanent New York office, which represents the Bureau of Applied Botany of the Agricultural Scientific Committee, and of which the undersigned is now in charge.

The object of this office is to secure seeds and other material needed for the work of the Russian Bureau of Applied Botany. We hope to widen and permanently maintain the cordial contact recently established with American institutions and individuals in corresponding lines of research work, as well as with the various seed concerns. The office has already been in existence for three months, and during this short period was in a position to forward nearly 5,000 packages of seeds to Russia for the experimental stations; also, several boxes of agricultural and scientific literature received from various American institutions.

Professor N. I. Vavilov expects to return to Petrograd in February, 1922, after a brief visit to England, Sweden and Germany. Since mail is now being accepted for Russia, all letters to Professor Vavilov may be addressed directly to him at the Bureau of Applied Botany, Morskaja, 44, Petrograd, Russia. Books and parcels should be addressed to Mr. D. N. Borodin, 110 West 40th Street (Room 1603), New York City.

D. N. BORODIN,
Agricultural Explorer.

NEW YORK CITY

MEMORIAL TO WILHELM WUNDT

PROFESSOR PFEIFER, the sculptor, tells me that the sum of Mk. 25,000 is still needed for the execution in marble of his monumental bust of Wundt. Family and friends all approve the bust, which was shown last June in the Aula of the University of Leipzig, and hope that it may be transferred from plaster to the more durable material and placed permanently in the Psychological Laboratory. Subscriptions (a thousand marks may now be sent for about six dollars) will be received by Professor Felix Krueger, Psychologisches Institut der Universität (Johanneum), Leipzig, Germany.

E. B. TITCHENER

CORNELL UUIVERSITY,
JANUARY 24, 1922

THE RHODESIAN SKULL[1]

Of greatest interest was the discussion of the recently unearthed Rhodesian skull at a recent meeting of the Anatomical Society of Great Britain. I do not know whether the American papers or scientific journals have published an account of it up to this time or not. You have probably had some information, but I thought you might like to have some first-hand, whether it be additional, or merely a repetition of what you have read.

The skull, along with some other human bones and many bones of animals, and some very crude instruments in flint and quartz, was found by the miners of the Broken Hill Mining Company in a cave which they unearthed some 60 feet below the surface in one of the mines in southern Rhodesia. It finally found its way into the British Museum here, and of course its investigation became the happy privilege of Dr. Smith-Woodward, who gave the description and showed the skull and other fragments of bone found with it, to the Anatomical Society.

The skull is in some features the most primitive one that has ever been found; at the same time it has many points of resemblance to (or even identity with) that of modern man.

Fortunately, the face is perfectly preserved. The supra-orbital region is astonishingly gorilla-like, in its enormous size and its unusually great extension laterally; the cranium is almost flat on top, extending backward from the huge supra-orbital ridges, rising only a little above the level of their upper borders. It is very broad in the back, however, so that its total capacity is surprisingly large. At

[1] Extract from a letter written from England to an American scientific man.

least one prominent authority thinks that this man had quite as much gray matter as the average modern man.

Another striking thing to be seen at the back of the skull is the evidence (in the size of the ridges and the contrasting deep impressions), of the tremendous and powerful mass of neck muscles the creature must have had. This is one of the points upon which is based the opinion that the skull is the most primitive yet found.

But to get back to the face! Dr. Smith-Woodward pointed out the fact that the suture of the nasal with the frontal bone is in a straight line rather than at a definite angle as in the apes; he also called attention to the small tubercle of bone in the mid-line of the nasal fossa which he says is distinctly a human trait. The zygomatic process is small. All of the bone of the face below the orbit is relatively undeveloped, but the *length* from the floor of the orbit to the alveolar border of the maxilla is phenomenal, as is also the length from the floor of the nasal cavity to the alveolar border of the maxilla. The palate is beautifully arched, and the teeth form a perfect horseshoe at its border. The wisdom tooth is reduced in size—another point in common with modern man and never found before in a fossil skull.

Unfortunately, the mandible was not found; the closest approach that could be found in the British Museum to the type this man had, was the Heidelberg jaw, but it is a bit too short and too narrow, though the ramus is too broad.

Another thing that has shocked the anthropologists is the unmistakable evidence of dental caries, and even of abscesses at the roots of the teeth. Now I guess we will have to lift the blame for caries off the shoulders of modern civilization. Won't we?

In contrast to the Neanderthal man who is supposed to have walked in a crouching position (because of the rather curved femur and other bits of evidence), this man is believed to have maintained the upright position, because the femur is relatively straight and when fitted to the tibia (which was also found) presents a perfectly good, straight leg.

But it would be altogether foolish for me to attempt any speculation on what I've seen! Of course, the scientific world here is much excited and many of its members are in danger of letting their imagination run away with them, but Dr. Eliot Smith at least is quoted as leaning to the belief that further study will reveal the fact that "the missing link" in the ancestry of man is represented in this individual—referring, of course to European man. The Neanderthal man would then represent a branch off of the main ancestral tree.

SPECIAL ARTICLES

A PRELIMINARY ATTEMPT TO TRANSMUTE LITHIUM

If an electron could be introduced into the nucleus of a lithium atom, a nucleus would be obtained which would possess the same resultant charge as a helium nucleus; if two electrons were introduced the nucleus that resulted would have the same charge as a hydrogen nucleus. Both of these products are gases the spectroscopic tests for which are of exceeding delicacy. It consequently does not appear entirely futile to subject lithium to bombardment by a stream of electrons traveling with a high velocity in the hope of causing some of them to penetrate the lithium nucleus. Experiments to this end were undertaken by the writer three years ago in the laboratory of Inorganic Chemistry of the Department of Chemistry, Cornell University. At that time it was hoped to be able to pursue the subject further with more powerful apparatus; that possibility now seems far distant so that it may not be amiss to record briefly the results of the preliminary experiments then made.

The experiment consisted essentially of bombarding either metallic lithium or some salt of lithium with as powerful as possible a stream of electrons, absorbing all of the gases present after the bombardment except hydrogen and helium, compressing this unabsorbed residue into a capillary Plücker tube and examining it spectroscopically. Such a procedure introduced many serious experimental difficulties. In the first place if metallic lithium was used, it is so readily volatile that

it could not be subjected to more than momentary bombardments. If, on the other hand, a salt of lithium was employed, it evolved gas rather copiously so that these experiments likewise had to be intermittent. At the time these experiments were made the writer did not have at his disposal either an alkaline earth oxide electrode nor a tungsten spiral to serve as source of electrons. As a consequence the pressure of gas in the bombardment tube had to be maintained within rather narrow limits. The procedure finally adopted as most satisfactory under the existing conditions consisted in introducing the requisite amount of oxygen gas into the thoroughly evacuated tube containing the lithium, which was present as oxide, and subsequently absorbing the oxygen in heated copper. Small quantities of other gases found to be present were absorbed by suitable reagents. The voltage then available, which was obtained from a very large spark coil, probably did not exceed 150,000 volts. With a bombardment chamber so designed that metallic lithium could be cooled by liquid air, or other refrigerant, while being subjected to a less concentrated beam of electrons from a tungsten filament electrode, it is probable that the bombardment could proceed indefinitely.

As a result of these bombardments a small unabsorbed residue showing strongly the spectrum of hydrogen always remained. Because of the excessive difficulty of removing last traces of water vapor from the surface of glass, there is no good reason for supposing that the hydrogen came from another source than water liberated and decomposed as a result of the bombardment. On the other hand it must be remarked that in view of the well known masking effect which hydrogen possesses over the development of the spectrum of helium, small quantities of helium that might have been present would not have been detected. Means were not at hand for entirely separating this hydrogen from any helium and searching for the latter by itself.

The purpose of this discussion is to suggest that with improved and more powerful apparatus there would be considerable hope of pursuing them to some sort of a definite conclusion.

For much advice in its design and for blowing many of the more difficult parts of the glassware of this apparatus, the writer was under great obligation to Dr. Harold S. Booth.

RALPH W. G. WYCKOFF
CALIFORNIA INSTITUTE
OF TECHNOLOGY
PASADENA, CAL.

THE EFFECT OF SODIUM HYDRATE UPON THE DIGESTIBILITY OF GRAIN HULLS

NUMEROUS experiments have been made during the last few years, particularly by German investigators, in attempts by various treatments to render more digestible the straws of the different cereals, legumes and cruciferæ. Among the methods employed for this purpose may be mentioned (*a*) the heating of finely ground straws under atmospheric pressure, (*b*) the treating of the fine straw with 3½ and 7 per cent. of sodium hydrate under 5 atmospheres, (*c*) cooking the straw in open kettles or cement ovens with 8 per cent. sodium hydrate for 12 hours, and (*d*) the treating of ground straw with cold sodium hydrate of various strengths for different lengths of time. The action of sodium hydrate as well as of calcium hydrate has proved effective, and the

DIGESTION COEFFICIENTS
AVERAGE TWO SHEEP

	DRY MATTER	ASH	CRUDE PROTEIN	FIBER	EXTRACT MATTER	FAT
Oat hulls untreated	36	00.00	0.00	53	34	0.00
Oat hulls treated	81	65	0.00	91	79	0.00
Rice hulls untreated*	5	10	0.00	12	5	0.00
Rice hulls treated	29	?	0.00	28	38	0.00

*One sheep only.

digestibility of some of the materials treated has been increased fifty or more per cent.

At the Massachusetts Experiment Station studies of the effect of quite dilute sodium hydrate upon the digestibility of oat and rice hulls have been completed and gives a preliminary statement of the results.

It is evident that the action of the soda did improve the digestibility of the oat hulls to a marked degree and of the rice hulls to a limited extent. A thorough study is being made of the chemical composition of oat, barley, rice and cottonseed hulls, and of flax shives, and of the action of different strengths of sodium hydrate and of other chemicals in improving their digestibility.

J. B. Lindsey

Massachusetts Agricultural
Experiment Station,

THE AMERICAN CHEMICAL SOCIETY

(*Continued*)

DIVISION OF FERTILIZER CHEMISTRY

F. B. Carpenter, *chairman*
H. C. Moore, *secretary*

The briquetting of mineral phosphates a promising method of conservation: William H. Waggaman and H. W. Easterwood. In connection with research work on the volatilization of phosphoric acid in a fuel fed furnace, preliminary work has shown that briquetting is a factor of prime importance. Samples from old phosphate deposits were found to be sufficiently high grade and contained enough natural binder (clay) to lend themselves to briquetting purposes. Also much phosphate rock from waste heaps could be used. It is only necessary to reduce the material for briquetting purposes to a point where it will pass a ten-mesh sieve and incorporate the necessary water into the mixture to give it the required plasticity. Where the composition of the material is such that sand must be added it was found that the necessary water could be added to the sand and coke and then this moistened mixture incorporated with the phosphate material. Coal presents a very promising possibility as a reducing agent in such briquettes since the volatile matter contained therein does not cause the briquettes to split open or disintegrate when heated.

Cyanamid in some fertilizer mixtures: W. S. Landis. A study of the behavior of Cyanamid in some fertilizer mixtures and in several standard brands of mixed fertilizer. The rapid conversion of cyanamid into urea and other salts was noted, but no dicyandiamid was found in any of the mixtures studied. Reactions with ammoniated base of both cyanamid and dicyandiamid were studied and unidentified complexes found to occur in such mixtures. Cyanamid when added in the proportions recommended for formulating this material did not change to dicyandiamid, and dicyandiamid intentionally added as such disappeared on mixing in such goods.

Comments on the formation of dicyandiamid in fertilizers: J. E. Breckenridge.

The value of the alkaline permanganate method: Chas. S. Cathcart.

Remarks on the permanganate methods for the determining of availability of organic nitrogen: J. E. Breckenridge.

Ten years experience with the neutral permanganate method in South Carolina: R. N. Brackett.

The composition of cotton seed: Thos. C. Law.

Cultivation and nitrogen fertilization: H. A. Noyes, J. H. Martsolf and H. T. King. A study of the comparative effects of different degrees of cultivation shows that with proper cultivation the average soil contains enough organic matter to stimulate bacterial activities and allow nitrates to accumulate during the growing season. Virgin soil rich in available organic matter gives nitrates in great excess of those needed by the growing plants. In early spring soils are depleted of nitrates and an early application of available nitrogen fertilizer is desirable and beneficial to stimulate plant growth until such a time as the soil has warmed up and responded to cultivation in increased bacterial activities. In no case studied have the authors been able to find the need for a second application of nitrogen fertilizer later in the season unless the soil did not receive proper cultivation. Nitrate production and accumulation resulting from and associated with thorough cultivation have a money value more than equal to the cost of the second application of nitrogen fertilizer.

The effect of fertilizers of various compositions on the reaction of soils: J. J. Skinner. The hydrogen ion concentration and lime requirements of soil fertilized with mixtures of various compositions are reported. In a fertilizer experiment with grass on the Hagerstown loam soil, acid phosphate, sodium nitrate, and potassium chloride was used singly, in combinations of two and in

combinations of three. The fertilizer constituents in the mixtures varied in ten per cent. stages, and is based on the triangle system. The soil has been fertilized annually for eleven years, using fifty pounds per acre of the constituents, P_2O_5, NH_3 and K_2O. The plots receiving mixtures of acid phosphate and potassium chloride have become acid, having a lower p_H value and a higher lime requirement than mixtures of acid phosphate, potassium chloride and sodium nitrate. The higher the p_H value and the smaller the lime requirement of the soils. Where the high nitrogen fertilizers were used, the subsoil has a lower p_H value than where high phosphorus acid mixtures were and the subsoil is more acid than the surface soil.

The present tendency of fertilizer experimentation: Oswald Schreiner.

Greensand as a source of fertilizer potash: R. Norris Shreve. A process is described whereby the enormous resources of potash now latent in the greensand beds of New Jersey are made available for fertilizer use. The process involves treating greensand with milk of lime at about 470° Fahr. for one hour. Caustic potash is the initial product but it is easily changed into other potash compounds. Potassium nitrate is shown to be the best form in which to produce the greensand potash for the fertilizer industry. Attention is called to the combination of two fertilizer essentials, namely, nitrogen and potash, in the one chemical with the consequent saving in transportation charges.

The development of accuracy in fertilizer analysis and some pitfalls in methods: P. McG. Shuey. Greater accuracy may be attained in the determination of oxide of iron and alumina by precipitation of aluminum phosphate either alone or in conjunction with ferric phosphate by having acetic acid present in the precipitating medium. A higher degree of accuracy is also reached by determining the metals separately. It is shown that by obtaining the weight of the combined phosphates and simply dividing by 2, results may be appreciably high. There has been a great development in the accuracy of nitrogen determinations in organic materials such as cottonseed meal, peanut meal, etc., within the last few years, as shown by the results obtained by the American Oil Chemists' Society. However, more accurate determinations are needed for nitrogen where nitrates are present.

The determination of free acid in ammonium sulfate: C. G. Atwater.

On the preparation of hydrochlorplatinic acid by means of hydrogen peroxide: Paul Rudnick. A solution of hydrochlorplatinic acid of the concentration required for the official Lindo-Gladding method of the A. O. A. C. for determining potash is readily prepared by converting the waste platinum from all sources into platinum black by any convenient means, dissolving the wet, well washed black by means of 30 per cent. hydrogen peroxide (free from organic preservatives) and hydrochloric acid gas, converting into potassium chlorplatinate and using only the pure potassium chlorplatinate so obtained as the starting point for the final solution. The chlorplatinate is dried and weighed, reduced with the purest obtainable sodium formate in alkaline solution, the resulting black washed by decantation only and without drying or igniting is suspended in 30 per cent. hydrogen peroxide and brought into solution by introduction of hydrochloric acid gas. Pyrex glass serves quite well for concentration of peroxide and for solution of the platinum black.

Various details in the determination of ammonia in cotton seed meal as summarized from eighty-six replies to a questionnaire sent to members of American Oil Chemists' Society: H. C. Moore.

Wool scouring wastes for fertilizer purposes: F. P. Veitch. More than 60,000 tons of fertilizer material combining the equivalent of 96,000 tons of kainit and 3,600 tons of tankage are now annually wasted in scouring wool. The U. S. Department of Agriculture has been making a careful study of the recovery and utilization of wool scouring wastes. A large number of samples of all grades of unscoured wool, of which this country uses more than 600,000,000 pounds annually, have been examined and it has been found that potash (K_2O) varies from 2 per cent. to 6 per cent. and averages approximately 4 per cent. for all grades; nitrogen varies from 3 per cent. to 0.9 per cent. and averages one half per cent., while grease varies from 3 per cent. to 30 per cent. and averages 15 per cent. for all grades. Both the potash and nitrogen are water soluble and therefore readily available to growing plants. Commercial base goods from concentrated wool scouring wastes and other wastes are rich in nitrogen. The "base goods" contained 6 per cent. of water soluble potash (K_2O) and 6 per cent. of nitrogen, was in excellent mechanical condition both for manufacturing and for application to the soil. The concentrated wool waste offers no difficulty in mixing with other fertilizer materials giving to the finished fertilizer a good

dark color and a strong odor, both of which are desirable properties for a fertilizer. The author is confident that this heretofore unused large store of fertilizer material can be made available to the fertilizer manufacturers and to the farmer and the damage and expense occasioned by the present practice of draining these wastes into the waters of the country can be greatly diminished.

The recovery of potash as a by-product in the blast furnace industry: WM. H. ROSS and ALBERT R. MERZ. The weighted average of the potash in the ores, coke and limestone used in the blast furnace industry amounts to approximately 0.2 per cent. for each material, which is less than one third as great as that found for the raw mix used in the cement industry. In the case of the ores, the potash ranges from 0.05 per cent. for Mesaba ores to over 2 per cent. for certain foreign ores. As the consumption of high potash ores is relatively small as compared with low potash ores, the weighted average of the potash in the ores consumed is less than the mean average found for different ore samples. On the basis of the weighted average the total potash in the ore, coke and limestone used in blast furnaces amounts, respectively, to 7.6, 1.8 and 4.5 lbs. per ton of pig iron, or to a total of 13.9 lbs. The potash in the slag amounts to 8.5 lbs., which leaves a balance for the potash volatilized of 5.4 lbs. per ton of pig iron. This amounts to a total for all plants of about 100,000 tons of potash as compared with 87,000 tons for the cement industry.

A historical review of the research showing the fertilizer value of sulphur: L. S. BUSHNELL. The writer proves the error of the last two of the following statements of Conn in "Agricultural Bacteriology": "In general, much less is known about the transformations of sulphur than of those of nitrogen. The reason for this is that sulphur is almost never deficient in soils, and the subject has never been considered of sufficient practical importance to justify extensive investigation." Results of research work conducted by various state experiment stations are cited where increase in yields from 50 to 1,000 per cent. were obtained when sulphur was used with alfalfa and other leguminous plants. It is shown that there is a decided loss of sulphur in soils cultivated for a number of years when compared with the corresponding virgin soils, and that the value of ammonium sulphate and acid phosphate as fertilizers is sometimes due to the sulphur and not to nitrogen or phosphorus. Attention is called to the faulty interpretation by others of Wolff's analyses of the ash of plants. Since large quantities of sulphur are lost by volatilization, the sulphur found in the ash is sometimes as little as one half per cent of the amount the plant contains.

Studies of the availability of organic nitrogenous compounds: C. S. ROBINSON. Various types of organic nitrogenous compounds containing definite atomic groupings were treated with alkaline permanganate solution according to the official method. The same thing was done with proteins and some organic base goods which were also analyzed by Van Slyke's method. Information was thus obtained as to specific groups ammonified by the permanganate method.

The preparation and composition of neutral ammoniun citrate solutions: C. S. ROBINSON. The work was divided into three parts as follows: (1) The preparation of solutions having definite compositions or reactions; (2) The relation between composition and reaction; (3) The relation between the reaction of the solution and its solvent action on calcium phosphate. It is shown that it is difficult to prepare a strictly neutral solution of ammoniun citrate with the usual indicators as ordinarily used. Physical chemical methods give accurate results but are not suitable for routine use. Analytical methods can be used to prepare any solution whose composition is fixed. The so-called colorimetric method using phenol red as the indicator is convenient and accurate. With citrate solutions ranging in reaction from pH 6.6 to 7.8 the magnitude of the variations in analytical results is usually small.

The potash situation: H. A. HUSTON. The potash situation was discussed from the standpoint of the relative quantities of soluble potash salts estimated by geologists to exist in the United States, France and Germany and development of these resources in the different countries. The geologists estimate that for each ton of soluble potash salts in the United States there are 10 tons in France and 6,000 tons in Germany. The estimated productive capacity of the existing potash properties in terms of actual potash is 80,000 tons for the United States, 250,000 tons for France and 3,850,000 tons for Germany. France has 13 completed shafts and 3 mills; Germany has 204 completed shafts and 17 mills. The ore suitable for producing sulfate of potash is not found in France.

CHARLES L. PARSONS,
Secretary